

WE CLAIM:

1. A catalyst deterioration detecting apparatus for an internal combustion engine, comprising:

a controller that:

5 detects an amount of oxygen stored in an upstream catalyst and an amount of oxygen stored in a downstream catalyst;

controls the amount of stored oxygen in the upstream catalyst by controlling an air-fuel ratio of gasses that
10 flow into the catalyst based on said detected amounts;

detects an oxygen storage capacity of the upstream catalyst based on said detected amount of stored oxygen in the upstream catalyst; and

determines degradation of said upstream catalyst
15 based on said detected oxygen storage capacity.

2. The apparatus of claim 1 further comprising an upstream exhaust gas oxygen sensor located upstream of said upstream catalyst, and a downstream exhaust gas oxygen sensor
20 located between said upstream catalyst and said downstream catalyst.

3. The apparatus of claim 2 wherein said controller further detects said amount of oxygen stored in said upstream catalyst and said amount of oxygen stored in said downstream catalyst based on said upstream and downstream sensors.
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4. A catalyst deterioration detecting apparatus for an internal combustion engine, comprising:

a controller that:

5 detects an amount of oxygen stored in an upstream catalyst and an amount of oxygen stored in a downstream catalyst;

controls the amount of stored oxygen in the upstream catalyst by controlling an air-fuel ratio of gasses that flow into the upstream catalyst;

10 detects an oxygen storage capacity of the upstream catalyst based on said detected amount of stored oxygen in the upstream catalyst during vehicle operation; and

determines degradation of said upstream catalyst based on said detected oxygen storage capacity.

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5. The apparatus of claim 4 further comprising an upstream exhaust gas oxygen sensor located upstream of said upstream catalyst, and a downstream exhaust gas oxygen sensor located between said upstream catalyst and said downstream

20 catalyst.

6. The apparatus of claim 5 wherein said controller further detects said amount of oxygen stored in said upstream catalyst and said amount of oxygen stored in said downstream

25 catalyst based on said upstream and downstream sensors.

7. A catalyst deterioration detecting apparatus for an internal combustion engine, comprising:

a controller that:

5 detects an amount of oxygen stored in an upstream catalyst and an amount of oxygen stored in a downstream catalyst;

controls the amount of stored oxygen in the upstream catalyst by controlling an air-fuel ratio of gasses that flow into the catalyst; and

10 detects an oxygen storage capacity of the upstream catalyst based on operation where the engine is operated lean to fill the upstream catalyst with oxygen and then the engine is operated rich; and

15 determines degradation of said upstream catalyst based on said detected oxygen storage capacity.

8. The apparatus of claim 7 further comprising an upstream exhaust gas oxygen sensor located upstream of said upstream catalyst, and a downstream exhaust gas oxygen sensor
20 located between said upstream catalyst and said downstream catalyst.

9. The apparatus of claim 8 wherein said controller further detects said amount of oxygen stored in said upstream.
25 catalyst and said amount of oxygen stored in said downstream catalyst based on said upstream and downstream sensors.

10. The apparatus of claim 7 wherein said lean operation is ended based on said downstream sensor.

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11. A catalyst deterioration detecting apparatus for an internal combustion engine, comprising:

a controller that:

5 detects an amount of oxygen stored in an upstream catalyst and an amount of oxygen stored in a downstream catalyst;

controls the amount of stored oxygen in the upstream catalyst by controlling an air-fuel ratio of gasses that flow into the catalyst; and

10 detects an oxygen storage capacity of the upstream catalyst based on operation where the engine is operated rich to deplete oxygen in the upstream catalyst and then the engine is operated lean; and

15 determines degradation of said upstream catalyst based on said detected oxygen storage capacity.

12. The apparatus of claim 11 further comprising an upstream exhaust gas oxygen sensor located upstream of said upstream catalyst, and a downstream exhaust gas oxygen sensor
20 located between said upstream catalyst and said downstream catalyst.

13. The apparatus of claim 12 wherein said controller further detects said amount of oxygen stored in said upstream
25 catalyst and said amount of oxygen stored in said downstream catalyst based on said upstream and downstream sensors.

14. The apparatus of claim 11 wherein said rich operation is ended based on said downstream sensor.

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15. A method for detecting deterioration of a catalyst for an internal combustion engine, the method comprising:
detecting an amount of stored oxygen in the catalyst;
controlling said amount of stored oxygen in the catalyst
5 by adjusting air-fuel ratio of the engine based on said detected amount of stored oxygen in the catalyst;
determining degradation of the catalyst based on said detected amount of stored oxygen in the catalyst.

10 16. The method of claim 15 wherein said control is based on an error between a set point amount of oxygen storage and said detected amount of stored oxygen in the catalyst.

15 17. The method of claim 16 wherein said set point is at a location in an exhaust system, said location moved based on engine operating conditions.

18. The method of claim 16 wherein set point location is moved along a length of the exhaust system.

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19. The method of claim 16 wherein set point location is moved between different positions in a catalyst brick.

20. The method of claim 16 wherein set point location is
25 moved between different catalysts.

21. The method of claim 16 wherein set point location is moved between different catalyst bricks.

30 22. The method of claim 15 wherein said adjusting air-fuel ratio of the engine includes adjusting injected fuel that enters the engine combustion chamber.

23. The method of claim 15 wherein said determining degradation includes determining a level of degradation.

24. The method of claim 15 wherein said determining
5 degradation includes determining a rate of degradation.

25. A method for detecting deterioration of a catalyst for an internal combustion engine, the method comprising:

detecting an amount of stored oxygen in the catalyst;
10 controlling said amount of stored oxygen in the catalyst by adjusting air-fuel ratio of the engine based on said detected amount of stored oxygen in the catalyst;

detecting an oxygen storage capacity of the catalyst based on said detected amount of stored oxygen in the
15 catalyst; and

determining degradation of the catalyst based on said detected oxygen storage capacity of the catalyst.

26. The method of claim 25 wherein said control is based
20 on an error between a set point amount of oxygen storage and said detected amount of stored oxygen in the catalyst.

27. The method of claim 26 wherein said set point is at a location in an exhaust system, said location moved based on
25 engine operating conditions.

28. The method of claim 26 wherein set point location is moved along a length of the exhaust system.

30 29. The method of claim 26 wherein set point location is moved between different positions in a catalyst brick.

30. The method of claim 26 wherein set point location is moved between different catalysts.

31. The method of claim 26 wherein set point location is moved between different catalyst bricks.

5 32. The method of claim 25 wherein said adjusting air-fuel ratio of the engine includes adjusting injected fuel that enters the engine combustion chamber.

10 33. The method of claim 25 wherein said determining degradation includes determining a level of degradation.

34. The method of claim 25 wherein said determining degradation includes determining a rate of degradation.